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(54) **DEVELOPING DEVICE**

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G03G 15/08 (2006.01)

(52) **U.S. Cl.**
CPC ***G03G 15/0893*** (2013.01); *G03G 15/0877* (2013.01); *G03G 15/0887* (2013.01); *G03G 15/0891* (2013.01); *G03G 2215/0833* (2013.01)

(58) **Field of Classification Search**
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See application file for complete search history.

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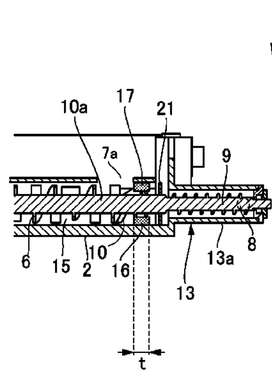
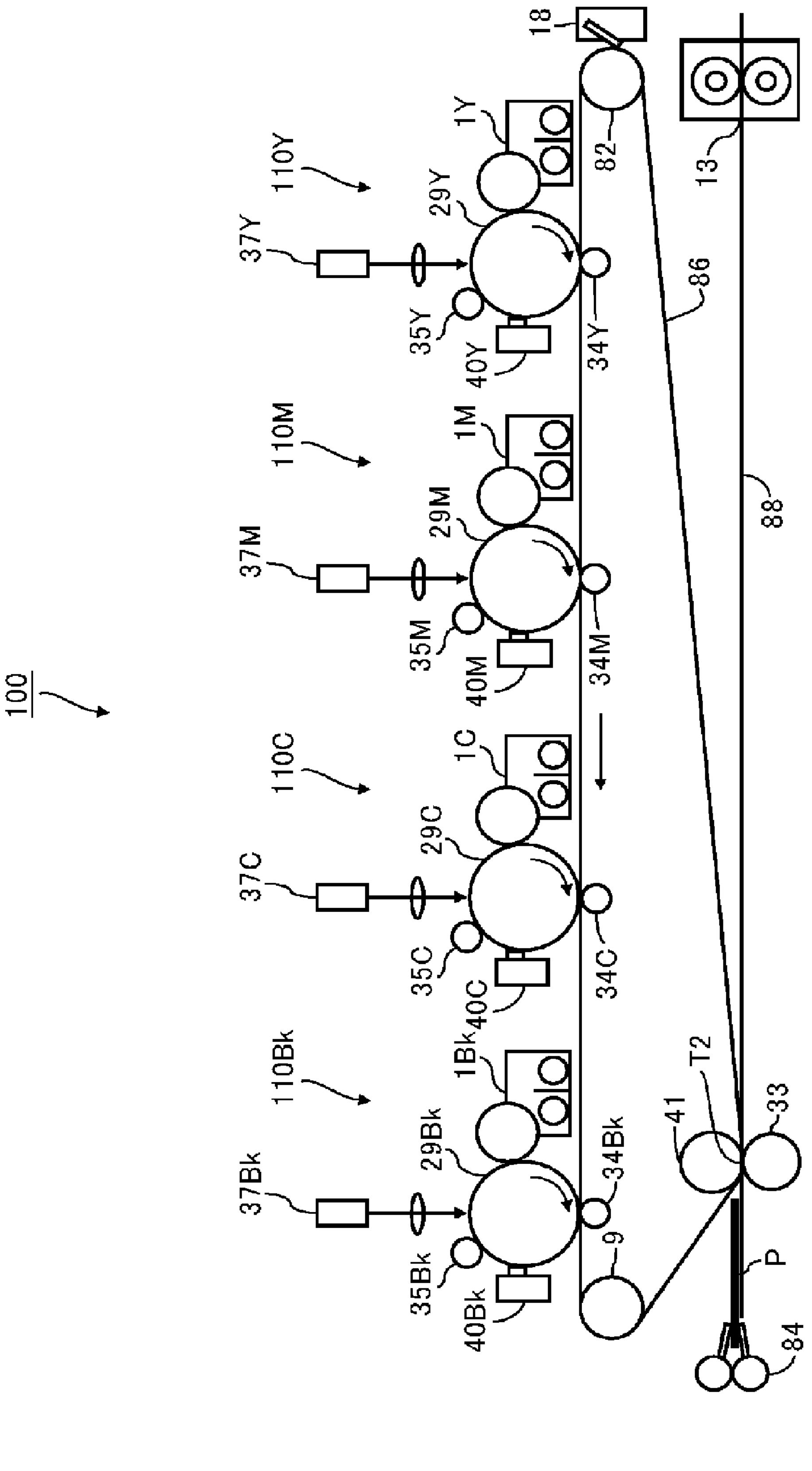
(57) **ABSTRACT**

A developing device includes a developer carrying member and first and second chambers. A feeding member provided in the second chamber includes a normal feeding portion, a reverse feeding portion, and a discharging portion. An opposing portion in the second chamber opposes a peripheral surface of the reverse feeding portion and is formed so that a first region of an upper half of the reverse feeding portion is broader in clearance with the second chamber than a second region, and includes a projected portion for forming a predetermined clearance with the reverse feeding portion by being projected from a side surface of the second chamber in a horizontal direction. The projected portion is disposed higher than a rotation center of the reverse feeding portion and lower than a top of the reverse feeding portion and is more remote from the first chamber than a rotation center of the feeding member.

10 Claims, 8 Drawing Sheets

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40C
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P
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Fig. 1

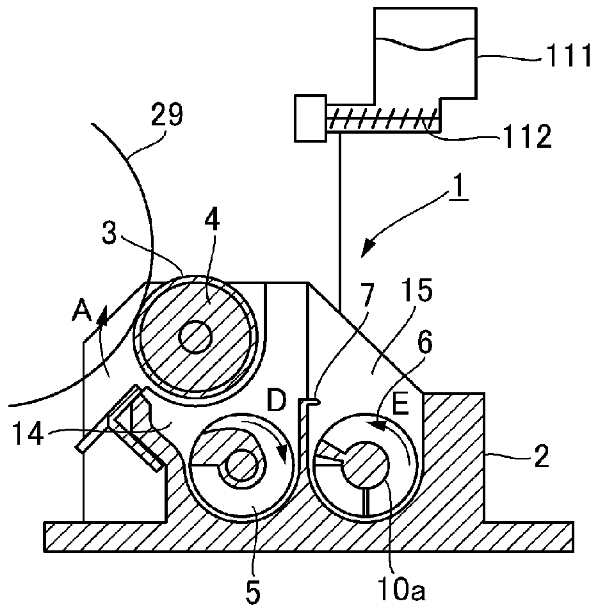
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Fig. 2

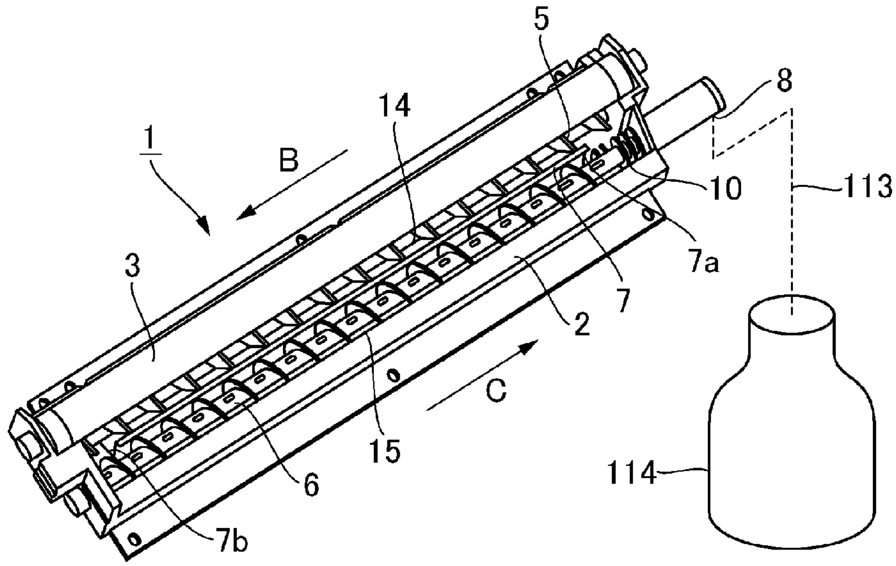
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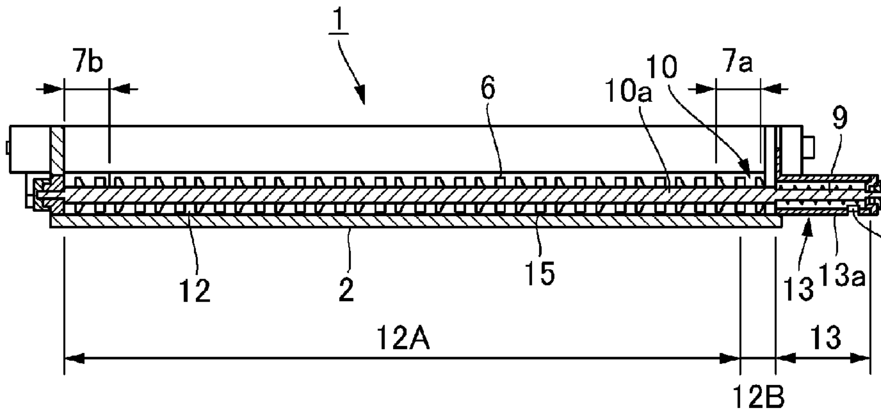
Fig. 3



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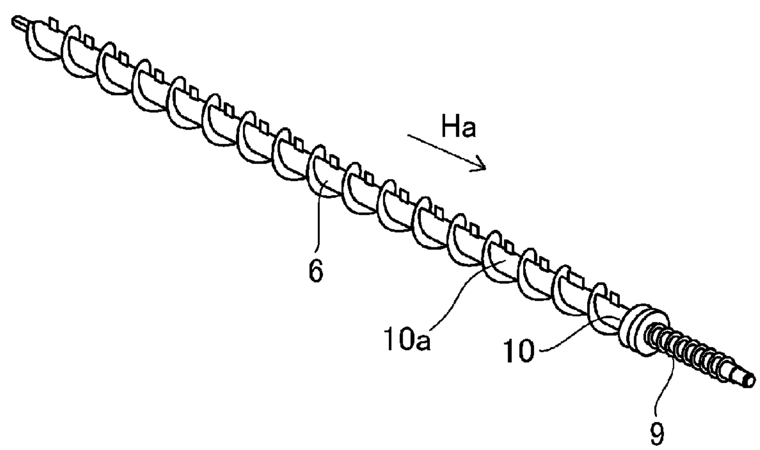

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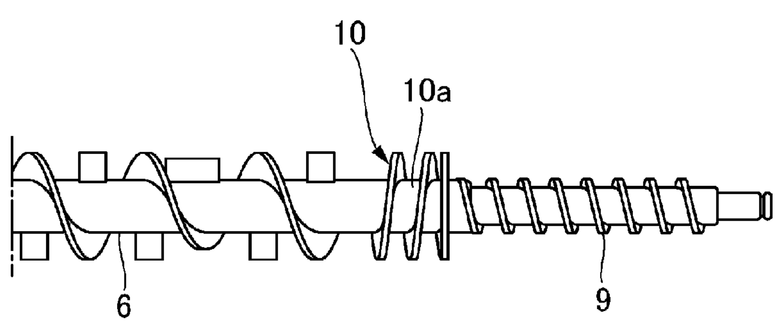

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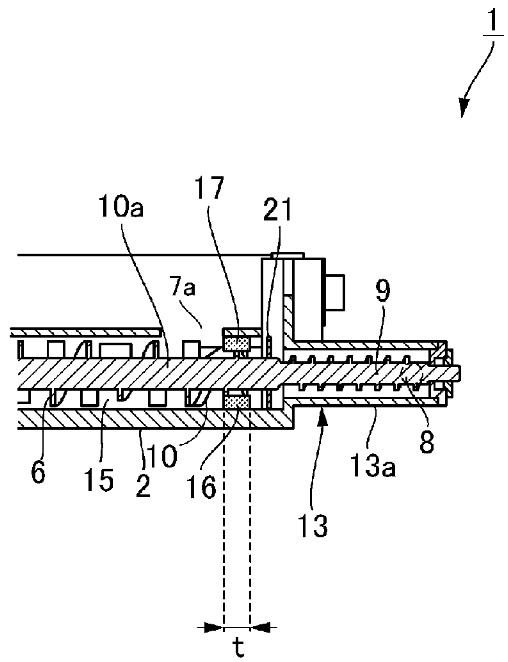

Fig. 7

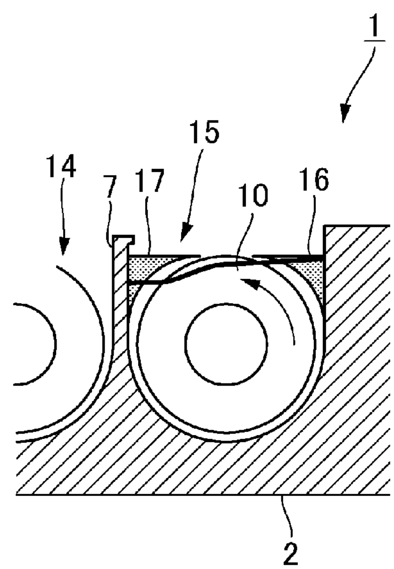

Fig. 8

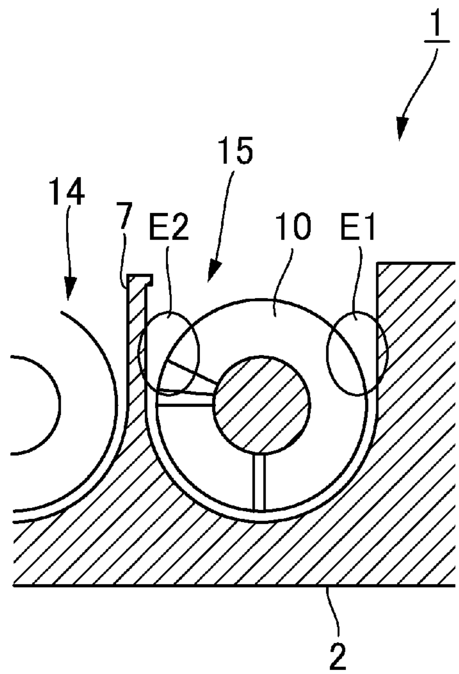

Fig. 9

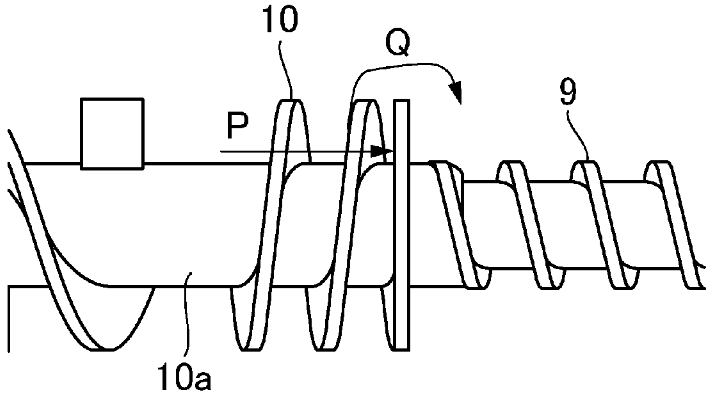

Fig. 10

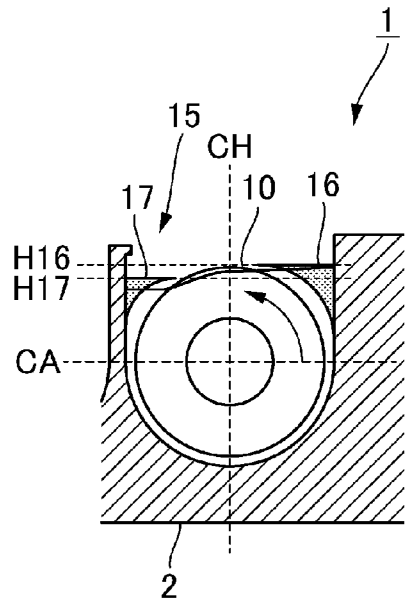

Fig. 11

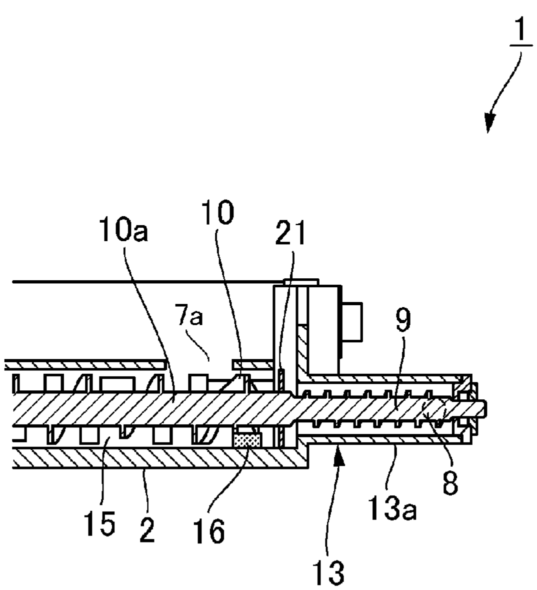

Fig. 12

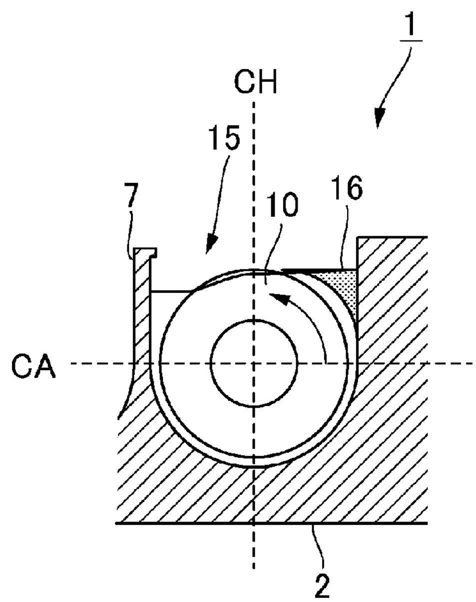

Fig. 13

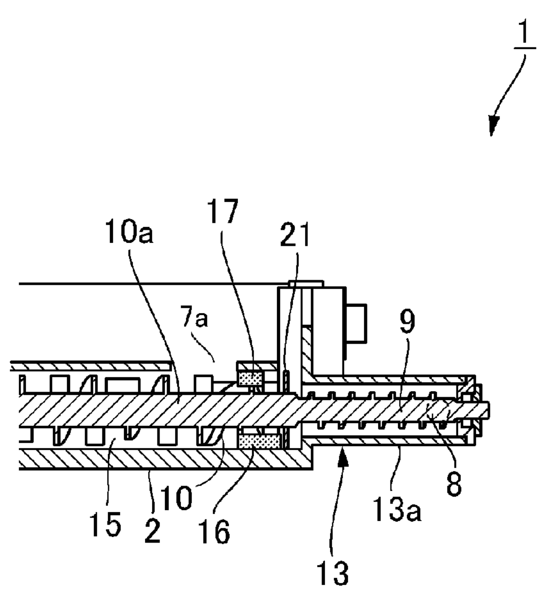

Fig. 14

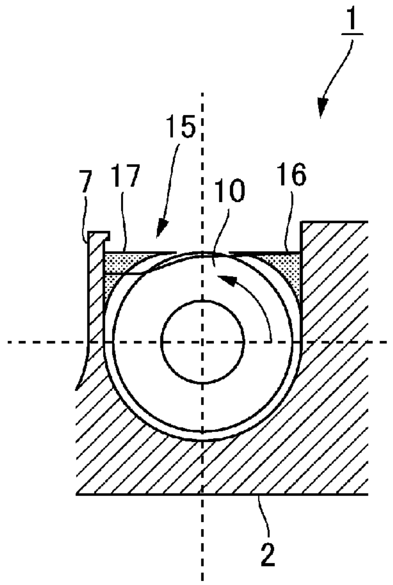

Fig. 15

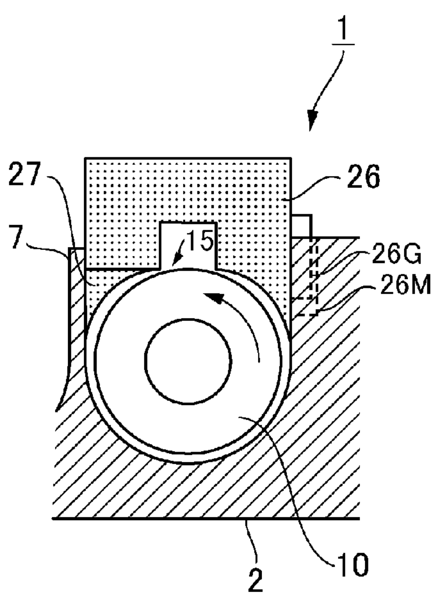

Fig. 16

DEVELOPING DEVICE

FIELD OF THE INVENTION AND RELATED ART

The present invention relates to a developing device for developing an electrostatic image on an image bearing member into a toner image with a developer containing a toner and a carrier, and specifically relates to the developing device capable of discharging an excessive developer from an inside of a developing container to an outside of the developing container.

In an image forming apparatus in which the toner image is transferred onto a sheet and then is fixed by application of heat and pressure, the developing device for developing the electrostatic image on the image bearing member into the toner image with the developer containing the toner and the carrier has been widely used. In the developing device using the developer containing the toner and the carrier, the developer is circulated between a first chamber and a second chamber which communicated with each other through openings at end portions, and the electrostatic image on the image bearing member is developed with the developer while carrying the developer on a developer carrying member provided in the first chamber. Then, the excessive developer is discharged from the developing device in a downstream side of the second chamber while steadily supplying the carrier into the developing device, whereby an amount of the developer in the developing device is kept at a substantially constant level while suppressing progress of an average degree of deterioration of the carrier in the developer (Japanese Laid-Open Patent Application (JP-A) 2010-256701 and JP-A 2010-237329).

In the developing device in JP-A 2010-237329, a reverse screw (type) feeding member for pushing back the developer to a discharge port is provided in a region downstream of the opening, in the second chamber, through which the developer is to be delivered to the first chamber in which the developer carrying member disposed in the first chamber, and a developer discharging portion is provided downstream of the reverse screw feeding member in the second chamber. Further, at a position adjacent to the opening, a "damming member" is provided opposed to an outer peripheral surface of the reverse screw feeding member, so that excessive flow-in of the developer toward the discharging portion is limited.

The "damming member" shown in JP-A 2010-237329 is provided for preventing the developer, flowing back to the second chamber through the opening from the first chamber in which the developer carrying member, from flowing into the discharging portion. For this reason, in a constitution of JP-A 2010-237329, the "damming member" is disposed at a position of a side surface, of two side surfaces, of the second chamber only in a side toward the first chamber. For this reason, the developer directly flowing from the second chamber into the discharging portion through a space, in a side opposite from the side toward the first chamber, of spaces at the two side surfaces of the second chamber cannot be limited sufficiently.

Further, in a side where a screw blade is raised, a height of a developer surface is higher than in a side where the screw blade is lowered as seen in a rotational axis direction of the screw in the second chamber. For that reason, in the constitution of JP-A 2010-237329, depending on a rotational direction of the screw blade in the second chamber, in some cases, discharge of the developer to the discharging portion through a space in a side where the developer surface is high cannot be efficiently suppressed.

In this case, when a temperature and a humidity of the developing device, a shape of particles of the developer, a developer feeding speed and the like are changed, an amount of the developer discharged from the developing device becomes insufficient or excessive, so that there is a possibility that the developer amount in the developing device varies.

SUMMARY OF THE INVENTION

A principal object of the present invention is to provide a developing device capable of discharging an excessive developer from an outside of a circulation path in a second chamber while circulating the developer between a first chamber in which a developer carrying member is provided and the second chamber in which a feeding member is provided.

Anther object of the present invention is to provide a developing device capable of suppressing unintentional discharge of a developer from a gap between the feeding member and an inner wall surface of the second chamber in a side opposite to the first chamber as seen in a rotational axis direction of the feeding member provided in the second chamber.

According to an aspect of the present invention, there is provided a developing device comprising: a developer carrying member for carrying a developer containing a toner and a carrier; a first chamber in which the developer to be supplied to the developer carrying member is to be fed; a second chamber, communicating with end portions of the first chamber, for forming a circulation path for circulating the developer between the first chamber and the second chamber; a feeding member, provided rotatably in the second chamber, including a normal feeding portion for feeding the developer in the circulation path in a circulation direction and including a reverse feeding portion, provided rotatably downstream of the normal feeding portion with respect to a feeding direction of the normal feeding portion, for feeding the developer from an outside of the circulation path toward an inside of the circulation path; a discharging portion, provided upstream of the reverse feeding portion of the second chamber with respect to a feeding direction of the reverse feeding portion, for discharging an excessive developer in the second chamber; and a non-magnetic regulating portion, provided above a rotation center of the feeding member so as to oppose the reverse feeding portion with respect to a rotational axis direction of the feeding member, for regulating a gap between an inner wall of the second chamber and the reverse feeding portion so as to be narrowed, wherein the regulating portion is provided at least in a position opposite from the first chamber with respect to the rotation center of the feeding member as seen in the rotational axis direction of the feeding member.

These and other objects, features and advantages of the present invention will become more apparent upon a consideration of the following description of the preferred embodiments of the present invention taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an illustration of a structure of an image forming apparatus.

FIG. **2** is an illustration of a structure of a developing device in vertical cross-section in Embodiment 1.

FIG. **3** is a perspective view of the developing device.

FIG. **4** is an illustration of a structure of the developing device in cross-section parallel to a shaft (axis).

FIG. **5** is a perspective view of a feeding screw.

FIG. **6** is an illustration of an end portion structure of the feeding screw.

FIG. **7** is a partially horizontal sectional view of the developing device in Embodiment 1.

FIG. **8** is a vertical sectional view of a stirring chamber as seen from an upstream side.

FIG. **9** is an illustration of a place where a developer is easily discharged.

FIG. **10** is an illustration of the reason why the developer is easily discharged.

FIG. **11** is a vertical sectional view of a stirring chamber in a developing device in Embodiment 2 as seen from an upstream side.

FIG. **12** is a partially horizontal sectional view of a developing device in Embodiment 3.

FIG. **13** is a vertical sectional view of a stirring chamber as seen from an upstream side.

FIG. **14** is a partially horizontal sectional view of a developing device in Embodiment 4.

FIG. **15** is a vertical sectional view of a stirring chamber as seen from an upstream side.

FIG. **16** is an illustration of a developing device in Embodiment 5.

DESCRIPTION OF THE EMBODIMENTS

Embodiments of the present invention will be specifically described with reference to the drawings.

Embodiment 1

Image Forming Apparatus

FIG. **1** is an illustration of a structure of an image forming apparatus **100**. As shown in FIG. **1**, the image forming apparatus **100** is an intermediary transfer type full color printer of a tandem type in which image forming portions **11**Y, **11**M, **11**C and **11**Bk for yellow, magenta, cyan and black are arranged along an intermediary transfer belt **86**.

At the image forming portion **11**Y, a yellow toner image is formed on a photosensitive drum **29**Y and then is transferred onto the intermediary transfer belt **86**. At the image forming portion **11**M, a magenta toner image is formed on a photosensitive drum **29**M and then is transferred onto the intermediary transfer belt **86**. At the image forming portions **11**C and **11**Bk, cyan and black toner images are formed on photosensitive drums **29**C and **29**Bk respectively, and then are transferred onto the intermediary transfer belt **86**.

A sheet (recording material) P is fed to a secondary transfer portion T**2** by a registration roller pair **84**. In a process in which the sheet P passes through the secondary transfer portion T**2**, the sheet P on which the toner images are transferred is fed to a fixing device **130** in which the toner images are heated and pressed and thus are fixed on the sheet P. Thereafter, the sheet P is discharged to an outside of the image forming apparatus.

(Image Forming Portion)

The image forming portions **11**Y, **11**M, **11**C and **11**Bk have the substantially same constitution except that colors of toners used in developing devices **1**Y, **1**M, **1**C and **1**Bk, respectively, are yellow, magenta, cyan and black, respectively, are different from each other. In the following, constituent elements of the image forming portions will be collectively described by omitting suffixes Y, M, C and Bk for representing difference in colors of yellow, magenta, cyan and black.

The image forming portion **110** includes, at a periphery of the photosensitive drum **29**, a charging roller **35**, an exposure device **37**, the developing device **1**, a transfer roller **34** and a drum cleaning device **40**. The photosensitive drum **29** is prepared by forming a photosensitive layer on an outer peripheral surface, and is rotated in an arrow direction in the figure. The charging roller **35** electrically charges a surface of the photosensitive drum **29** to a uniform potential. The exposure device (laser scanner) **37** scans the surface of the photosensitive drum **29** with a laser beam modulated on the basis of an image signal obtained by developing an image on a scanning line, so that an electrostatic image for the image is formed on the surface of the photosensitive drum **29**. The developing device **1** develops the electrostatic image into the toner image with a developer containing a toner and a carrier.

The transfer roller **34** forms a toner image transfer portion between the photosensitive drum **29** and the intermediary transfer belt **86**. By applying a transfer voltage to the transfer roller **34**, the toner image carried on the photosensitive drum **29** is transferred onto the intermediary transfer belt **86**. The drum cleaning device **40** collects a transfer residual toner deposited on the photosensitive drum **29** without being transferred onto the intermediary transfer belt **86**.

(Developing Device)

FIG. **2** is an illustration of a structure of a developing device in vertical cross-section in Embodiment 1. FIG. **3** is a perspective view of the developing device. FIG. **4** is an illustration of a structure of the developing device in cross-section parallel to a shaft (axis). FIG. **5** is a perspective view of a feeding screw. FIG. **6** is an illustration of an end portion structure of the feeding screw.

As shown in FIG. **2**, the developing device **1** accommodates, in a developing container **2**, the developer containing the toner (non-magnetic) and the carrier (magnetic). A mixing ratio between the toner and the carrier in the developer is about 1:9 in weight ratio. This ratio is not limited to the indicated numerical rate, but may be appropriately adjusted depending on a toner charge amount, a carrier particle size, a constitution of the image forming apparatus **100**, and the like.

The developing container **2** is provided with an opening at a portion of a developing region opposing the photosensitive drum **29**. A developing roller **3** is provided rotatably so as to be partly exposed through the opening. The developing roller **3** which is an example of a developer carrying member includes a magnet **4** provided therein in a non-rotational state. The developing roller **3** is formed of a non-magnetic aluminum material and is rotated in an arrow A direction during a developing operation. The developing roller **3** carries the developer, in the developing container **2** in a layer shape and then feeds the developer to the developing region, and thus supplies the toner to the photosensitive drum **29**, so that the electrostatic image is developed into the toner image. The developer after the developing operation is collected in the developing container **2** with rotation of the developing roller **3**.

As shown in FIG. **3**, the developing container **2** is divided into a developing chamber **14** and a stirring chamber **15** by a partition wall **7**. The partition wall **7** is provided between a feeding screw **5** and a feeding screw **6**, and an opening **7***a* is provided in a rear side of the partition wall **7**, and an opening **7***b* is provided in a front side of the partition wall **7**. The stirring chamber **15** and the developing chamber **14** communicate with each other through the openings **7***a* and **7***b* provided in the partition wall **7**, thus forming a circulation path of the developer. Between the feeding screws **5** and **6**, the partition wall **7** is provided, and in order to smoothly circulate the developer, the openings **7***a* and **7***b* are provided in the rear side and the front side, respectively, of the partition wall **7**.

In the developing chamber **14**, the feeding screw **5** is provided. The feeding screw **5** stirs and mixes the developer in the developing chamber **14**. In the stirring chamber **15**, the feeding screw **6** is provided. The feeding screw **6** stirs and mixes the developer in the stirring chamber **15**. The feeding screws **5** and **6** deliver the developer through the opening and **7***b* to feed the developer in arrow B and C directions, thus smoothly circulating the developer. By these feeding screws **5** and **6**, the developer is circulated in the developing container **2** while being stirred and mixed.

A two-component developing system in which the development is made using the developer containing the toner and the carrier is, compared with other developing systems, excellent in stability of an image quality and durability of the developing device, but on the other hand, is liable to generate deterioration of the carrier with cumulative long-term use.

For that reason, the developing device **1** in Embodiment 1 includes an automatic developer exchange mechanism. The automatic developer exchange mechanism supplies a supply developer containing a carrier and a toner in an amount corresponding to a consumed amount of the toner by the developing operation of the photosensitive drum **1**, and discharges an excessive developer (carrier) from the developing device **1** to accumulate the excessive developer in a collecting container. The automatic developer exchange mechanism discharges the excessive developer substantially simultaneously with the supply of the supply developer, and therefore it is possible to stabilize a characteristic of the developer as a whole without causing upsizing of the image forming apparatus and a sudden rise in cost. The automatic developer exchange mechanism eliminates the need for a manual operation such as developer exchange or developing device exchange, thus achieving an improvement in maintenance property and a reduction in running cost.

(Supply of Developer)

As shown in FIG. **2**, a developer supplying portion **111** supplies, to the stirring chamber **15** of the developing device **1**, the supply developer containing the toner and the carrier. The developer supplying portion **111** uses the supply developer containing the carrier in the toner at a certain proportion (weight ratio: about 10%). However, a carrier containing ratio is not limited thereto.

The developer supplying portion **111** rotates an unshown supply screw every image formation of one sheet, and supplies the supply developer, containing the toner in an amount corresponding to an amount of the toner consumed by the image formation, toward an upstream side of the feeding screw **6** of the developing container **2** with respect to a developer feeding direction. The developer supplying portion **111** supplies the supply developer so as to maintain a toner content (a weight ratio of the toner per unit weight of the developer) of the developer in the developing container **2** at a certain level. The toner in the amount corresponding to the amount of the toner consumed by the image formation is supplied, as the supply developer containing the carrier at a certain proportion, toward the upstream side of the feeding screw **6** of the developing container **2** with rotation of a supplying screw **112**.

The toner is consumed by the image formation, but the carrier contained in the supply developer at the certain proportion is not consumed by the image formation, and therefore the carrier remains in the developing container **2** and is continuously circulated. For this reason, when the supply of the supply developer is repeated with the image formation, the amount of the developer in the developing device **1** gradually increases.

As shown in FIG. **4**, the developer which became excessive in the developing container **2** is discharged to an outside of the developing device **1** through a developer discharge opening **8** of a discharge path connected to the stirring chamber **15** in a downstream side of the stirring chamber **15**. The excessive developer in the stirring chamber **15** overflows and is discharged through the discharge path **13**, so that the amount of the developer in the developing container **2** is maintained in a predetermined range. The toner in the amount corresponding to the amount of the consumed toner is supplied by the supply developer, and at the same time, the developer in which the supplied carrier becomes excessive is discharged. Replacement of the developer is automatically carried out gradually so as to maintain the developer in the developing container **2** at a certain level.

(Developer Discharging Portion)

As shown in FIG. **3**, in the developing chamber **14** which is an example of a first chamber, the developer to be supplied to the developing roller **3** is fed. The stirring chamber **15** which is an example of a second chamber communicates with the developing chamber **14** at end portions to form a circulation path along which the developer is circulated between the stirring chamber **15** and the developing chamber **14**.

As shown in FIG. **4**, the feeding screw **6** which is an example of a feeding member is provided rotatably in the stirring chamber **15**. A normal feeding portion of the feeding screw **6** feeds the developer, positioned in the circulation path, in a circulation direction in a normal feeding region **12**A. A return screw **10** which is an example of a reverse feeding portion provided rotatably in a reverse feeding region **12**B positioned downstream of the normal feeding portion with respect to the feeding direction, and feeds the developer, positioned outside the circulation path, toward an inside of the circulation path. A discharge path (discharge feeding region) **13**, which is an example of a discharging portion, is provided upstream of the return screw **10** of the stirring chamber **15** with respect to a developer feeding direction of the return screw **10**, and the excessive developer in the stirring chamber **15** is discharged along the discharge path **13**.

As shown in FIG. **5** with reference to FIG. **6**, the feeding screw **6**, the return screw **10** and a discharging screw **9** include a common rotation shaft (axis) **10***a*. The rotation shaft **10***a* integrally rotates the feeding screw **6** having a feeding performance in a normal direction, the return screw **10** having a feeding performance in a reverse direction, and the discharging screw **9** having the feeding performance in the normal direction. As shown in FIG. **6**, the discharging screw **9** is connected with the feeding screw **6** via the return screw **10** in the downstream side with respect to the feeding direction of the feeding screw.

As shown in FIG. **3**, the return screw **10** returns the developer, to the opening **7***a*, moving toward the discharge path **13** by being pushed by the developer fed by the feeding screw **6**. As a result, a flow of the developer in front of the opening **7***a* is weakened, and a height of the developer is increased, so that the developer flows into the developing chamber **14** through the opening **7***a*.

As shown in FIG. **4**, the discharging screw **9** is positioned in the discharge path **13** connected to the reverse feeding region **12**B of the stirring chamber **15**. The developer discharge opening **8** is disposed at an end portion of the discharge path **13**. An inner diameter of the discharge path **13** is somewhat smaller than an inner diameter of the reverse feeding region **12**B of the stirring chamber **15**, and a height of a bottom of the discharge path **13** is somewhat higher than a height of a bottom of the reverse feeding region **12**B of the stirring chamber **15**. The discharging screw **9** disposed in the discharge path **13** feeds the excessive developer, overflowing into the discharge path **13**, toward the developer discharge opening **8**, and discharges the excessive developer through the developer discharge opening **8**.

When the developer amount in the developing container **2** and thus a developer height at a position of the return screw **10** exceeds a predetermined level, the developer rides over the return screw **10** and flows into the discharge path **13**. The developer overflowing into the discharge path **13** is fed to the discharging screw **9** to be fed to the developer discharge opening **8**. As shown in FIG. **3**, the developer discharged through the developer discharge opening **8** pass through a feeding pipe path **113** and then is collected and accumulated in a collecting container **114**.

(Characteristic Portion of Embodiment 1)

FIG. **7** is a partially horizontal sectional view of the developing device in Embodiment 1. FIG. **8** is a vertical sectional view of a stirring chamber as seen from an upstream side. FIG. **9** is an illustration of a place where a developer is easily discharged. FIG. **10** is an illustration of the reason why the developer is easily discharged.

As shown in FIG. **8**, a gap in view of a dimension tolerance of an outer diameter of the return screw **10** and an inner diameter of the stirring chamber **15** is provided between the return screw **10** and an inner wall of the stirring chamber **15**, so that the return screw **10** is prevented from interfering with the inner wall of the stirring chamber **15**. When the return screw **10** interferes with the inner wall of the stirring chamber **15**, at an interfering portion, agglomeration of the developer generates and an operation noise becomes large in some cases.

However, as shown in FIG. **9**, when the gap exists between the return screw **10** and the inner wall of the stirring chamber **15**, leakage of the excessive developer is liable to gape through regions E**1** and E**2** each shown by an ellipse. The leakage of the excessive developer through the regions E**1** and E**2** promotes the developer discharge with drive of the developing device **1**. When the leakage of the excessive developer through the regions E**1** and E**2** continues and the amount of the developer circulating between the developing chamber **14** and the stirring chamber **15** is below a normal range, the developer amount in the developing chamber **14** becomes insufficient and thus the developing roller **3** is not sufficiently coated with the developer, so that density non-uniformity generates in an output image in some cases.

As shown in FIG. **9**, a developer leakage phenomenon that the developer rides over the return screw **10** is liable to generate in an upper-half region of the return screw **10** in vertical cross-section of a shaft (axis) of the return screw **10**. In a lower-half region of the return screw **10** in vertical cross-section of the shaft of the return screw **10**, the developer loses flowability by its own weight and pressure, and therefore little developer leakage is generated.

As shown in FIG. **10**, in a region close to an outward inner wall of the return screw **10**, as shown by an arrow P, the developer fed toward a downstream side in the stirring chamber **15** is liable to ride over the return screw **10** by momentum thereof to flow out. On the other hand, in a region close to the return screw **10** and an inside region of the return screw **10**, as shown by an arrow Q, the developer is prevented from moving by a developer feeding force toward an upstream side of the return screw **10**, so that the developer does not readily ride over the return screw **10** and thus does not readily flow out.

Therefore, in this embodiment, on the inner wall of the stirring chamber **15**, damming members **16** and **17** are provided in the neighborhood of the return screw **10**. The damming member **17** was provided on the inner wall (partition wall **7**) in a side close to the developing chamber **14** in the upper-half region of the return screw **10** in the vertical cross-section of the shaft of the return screw **10** and the damming member **16** was provided on the inner wall in a side remote from the developing chamber **14** in the upper-half region. In the upper-half region of the return screw **10** in the vertical cross-sectional of the shaft of the return screw **10**, the developer likely to flow out through the gap between the return screw **10** and the inner wall of the stirring chamber **15** was returned to the circulation of the developer in the developing container **2** by being brought into collision with the damming members **16** and **17**.

(Size of Damming Member)

The damming members **16** and **17** are disposed on an outer peripheral surface of the return screw **10** so as to oppose each other, and a gap (spacing) therebetween is designed so as to be 0.6 mm. With a smaller gap between the damming members **16** and **17**, a larger degree of the developer leakage is suppressed, but there is a need to ensure the gap to the extent such that the rotating return screw **10** does not interfere with the damming members **16** and **17**. The gap return the damming members **16** and **17** is a value designed in view of a dimension tolerance of the return screw **10** and the damming members **16** and **17**.

As shown in FIG. **7**, a width t of the damming members **16** and **17** with respect to a screw shaft (axis) direction may preferably be a pitch width (3.0 mm in this embodiment) or more of the return screw **10**. In the case where the width of the damming members **16** and **17** is less than the pitch width of the return screw **10**, in some cases, the developer leaks out through between the rotation shaft **10***a* of the return screw **10** and each of the damming members **16** and **17**. In this embodiment, the width t of the damming members **16** and **17** was 3.5 mm. However, even when the width t of the damming members **16** and **17** is less than the pitch width of the return screw **10**, a large effect is obtained when compared with the case where there is no damming member as shown in FIG. **5**. For this reason, it is not necessarily essential that in the constitution of the present invention, the width of the damming members **16** and **17** is the screw pitch width or more.

The damming members **16** and **17** are resin-molded integrally with the developing container **2**. As shown in FIG. **4**, the rotation shaft **10***a* on which the feeding screw **6**, the return screw **10** and the discharging screw **9** are formed is inserted into the stirring chamber **15** along a rotational axis direction from a side opposite from the discharge path **13**. For that reason, the damming members **16** and **17** do not constitute an obstacle to assembling of the rotation shaft **10***a*.

(Position of Damming Member)

As shown in FIG. **7**, the damming members **16** and **17** are shifted to and disposed at the upstream side of the return screw **10**. The damming members **16** and **17** may preferably be disposed in an upstreammost side in a range opposing the return screw **10**, i.e., at a downstreammost position of the feeding direction of the return screw **10**. As shown in FIG. **8**, with a lower surface of the developer in contact with the return screw **10**, the gap between the return screw **10** and the inner wall of the stirring chamber **15** becomes smaller. For this reason, as the damming members **16** and **17** are shifted toward the upstream side (the downstream side with respect to the feeding direction) of the return screw **10** in a larger amount, an effect of returning the developer, like to leak out from the developing container **2**, to the circulation path in the developing container **2** becomes larger. However, even when the damming members **16** and **17** are shifted to the downstream side of the return screw **10**, a large effect is obtained when compared with the case where these is no damming member as shown in FIG. **9**. For this reason, it is not necessarily essential that in the constitution of the present invention, the width of the damming members **16** and **17** is shifted to the upstream side of the return screw **10**.

In this embodiment, a side where a screw blade raises with rotation of the feeding screw **6** when the feeding screw **6** is viewed from the rotational axis direction of the feeding screw **6** is a side opposed from the developing chamber **14** with respect to a rotation center of the feeding screw **6**. For this reason, during an operation, as shown in FIG. **8** by a solid line, in this embodiment, the developer surface is formed, and in the case where the developer amount in the stirring chamber **15** becomes excessive, the developer rides over the damming member **16** and flows into the downstream side, so that the developer is discharged from the developing container **2**. As shown in FIG. **8**, in this embodiment, the damming members **16** and **17** are not formed at a top portion of the return screw **10**, and therefore in the case where the developer amount in the developing container **2** becomes excessive, necessary discharge of the developer is not prevented by the damming members **16** and **17**.

As a Comparison Example, the constitution of the developing device shown in JP-A 2010-237329 will be compared with the constitution of the developing device in Embodiment 1.

Referring to FIG. **3**, in the Comparison Example, on the inner wall (partition wall **7**) provided with the opening (**7***a*), the damming member (**17**) is provided. Alternatively, in the Comparison Example, the damming member (**17**) is provided on the inner wall (partition wall **7**) in a side where the developer (surface) is lowered with the rotation of the feeding screw **6**. Further, the damming member (**17**) has an effect of damming up the developer flowing back from the upstream side of the feeding screw (**5**) toward the downstream side of the feeding screw (**6**) through the opening (**7***a*).

However, the damming member (**17**) cannot dam up the developer leaking out toward the downstream side of the stirring chamber **15** through a gap between the return screw **10** and the inner wall in a side opposite from the side where the opening **7***a* is provided. Alternatively, the damming member (**17**) cannot dam up the developer leaking out toward the downstream side of the stirring chamber **15** through the gap between the return screw **10** and the inner wall in a side where the developer (surface) is raised with the rotation of the feeding screw **6**. This is because in the Comparison Example, the damming member **16** shown in FIGS. **7** and **8** is not provided.

As shown in FIG. **8**, in the side where the developer is raised with the rotation of the feeding screw **6**, the developer surface becomes higher than in a side where the developer is lowered with the rotation of the feeding screw **6**. For this reason, in the side where the developer is raised with the rotation of the feeding screw **6**, a cross-sectional area of a flow of the developer which rides over the return screw **10** and then flows toward the downstream side of the stirring chamber **15** becomes larger than in the side where the developer is lowered with the rotation of the feeding screw **6**.

As shown in FIG. **3**, in the inner wall side where the opening **7***a* is provided, the developer flows out into the developing chamber **14**, and therefore, the surface of the developer is lower than in the inner wall side where the opening **7***a* is not formed (i.e., when there no escape route). For this reason, in the inner wall side where the opening **7***a* is provided, the cross-sectional area of the flow of the developer which rides over the return screw **10** and flows toward the downstream side of the stirring chamber **15** is smaller than in the inner wall side where the opening **7***a* is not provided.

As shown in FIG. **9**, the developer surface is higher in a region E**1** remote from the partition wall **7** than in a region E**2** close to the partition wall **7**, and therefore a leaking amount of the developer through the region E**1** is larger than through the region E**2**. When the lowest point of the return screw **10** is taken as a starting point, in the upstream region E**1** with respect to the rotational direction of the return screw **10**, the developer surface is higher than in the downstream region E**2** with respect to the rotational direction of the return screw **10**, and therefore the leaking amount of the developer through the region E**1** is larger than through the region E**2**.

Accordingly, the flow of the developer which rides over the return screw **10** and flows toward the downstream side of the stirring chamber **15** is largely localized toward the damming member **16** side, and therefore an effect of limiting the developer to be discharged from the stirring chamber is considerably larger by the damming member **16** than by the damming member **17**. The constitution of the developing device in the Comparison Example, in which only the damming member (**17**) is provided, is not efficient in suppressing the amount of the developer leaking out toward the downstream side of the stirring chamber **15** through the gap between the return screw **10** and the inner wall of the stirring chamber **15**. In the developing device of the Comparison Example in which the damming member **16** is not provided, particularly in the constitution in which the developer surface is higher in the region E**1** side, the suppression of the developer amount is not sufficient.

In Embodiment 1, the reason why the side where the screw blade is raised with the rotation of the feeding screw **6** is the side opposite from the developing chamber **14** is as follows. In order to facilitate the supply of the developer toward the developing roller **3** in the developing chamber **14**, the feeding screw **5** is rotated clockwisely. Further, the feeding screws **5** and **6** establish drive transmission by direct engagement of gears at shaft end portions thereof, and therefore the feeding screws **5** and **6** are rotated in reverse directions from each other. For this reason, the rotational directions are as in Embodiment 1.

Accordingly, even in a constitution, opposite to the constitution in Embodiment 1, in which the developer surface is higher in the region E**2** shown in FIG. **9** than in the region E**1**, the present invention can be carried out. That is, such a constitution is the case where when the feeding screw **6** is seen in the rotational axis direction thereof, the side where the screw blade is raised with the rotation of the feeding screw **6** is the side close to the developing chamber **14** with respect to the rotation center of the feeding screw **6**.

In the constitution of Embodiment 1, the damming members **16** and **17** which are an example of a regulating portion are provided above the rotation center of the feeding screw **6** so as to oppose the return screw **10** at positions at least in the side opposite from the side toward (close to) the developing chamber **14** with respect to the rotation center of the feeding screw **6**. The damming member **16** regulates the gap between the inner wall of the stirring chamber **15** and the return screw **10** so as to be narrowed. The damming member **17** regulates the gap between the stirring chamber **15** and the return screw **10** in the side toward the developing chamber **14**, which is an example of the first chamber, with respect to the rotation center of the feeding screw **6** so as to be partly narrowed. The damming member **16** is provided in the upstream side of the return screw **10** with respect to the rotational axis direction of the feeding screw **6**.

As described above, according to Embodiment 1, the damming members **16** and **7** are provided, and therefore the effect of suppressing the amount of the developer discharged by flowing out toward the downstream side of the stirring chamber **15** is sufficient. Accordingly, the developer amount in the developing container **2** can be properly maintained, so that stable image formation can be effected for a long time. The damming member **16** is provided, and therefore the leakage of the developer through the gap between the return screw **10** and the inner wall of the stirring chamber **15** is suppressed, so that it is possible to suppress a fluctuation in discharge of the developer through the region E**1** in FIG. **9**. As a result of the suppression of the leakage of the excessive developer, the developer amount in the developing container **2** is stabilized.

Embodiment 2

FIG. **11** is a vertical sectional view of a stirring chamber of a developing device in Embodiment 2 as seen from an upstream side. The developing device in this embodiment is constituted similarly as in Embodiment 1 except that a size of the damming member provided on the inner wall in the side where the opening is provided is small. Accordingly, in FIG. **11**, constituent elements common to Embodiments 1 and 2 are represented by the reference numerals or symbols common to FIG. **11** and FIGS. **7-10**, and will be omitted from redundant description.

As shown in FIG. **8**, the developer surface is high in the damming member **16** side, and therefore in the case where both heights of the damming members **16** and **17** are made higher than those in FIG. **8**, the developer which becomes excessive in the developing container **2** cannot be discharged in the damming member **17** side. On the other hand, in the case where both of the heights of the damming members **16** and **17** are made lower than those in FIG. **8**, the developer in the developing container **2** is excessively discharged in the damming member **16** side.

Therefore, as shown in FIG. **11**, in this embodiment, correspondingly to an inclination of the developer surface, the height of the damming member **16** is higher than the height of the damming member **17**. The damming members **16** and **17** were disposed at different heights in two regions (E**1** and E**2** in FIG. **9**) which oppose each other at an upper-half portion of the return screw **10**. The height H**16** of the damming member **16** disposed in the region E**1** was made higher than the height H**17** of the damming member **17** disposed in the region E**2**. In the figure, the return screw **10** has a center CH with respect to the horizontal direction and a Comparison Example CA with respect to the height direction.

According to Embodiment 2, the damming members **16** and **17** are provided, and therefore the developer which leaks out toward the downstream side of the stirring chamber **15** through the gap between an upper-half peripheral surface of the return screw **10** and the inner wall of the stirring chamber **15** and then is excessively discharged is decreased in amount so that the developer amount in the developing container **2** is stabilized.

According to Embodiment 2, the heights of the damming members **16** and **17** are made different from each other, and therefore when the developer in the developing container **2** becomes excessive, the excessive developer overflows both of the damming members **16** and **17** at the same time and then is quickly discharged to the downstream side. For this reason, the developer in the developing container **2** does not readily become excessive. According to Embodiment 2, the height of the damming member **16** in the region E**1** where the developer is liable to leak out is made higher than the height of the damming member **17** in the region E**2** where the developer does not readily leak out, and therefore the leakage of the excessive developer can be suppressed effectively.

According to the constitution of Embodiment 2, the heights of the damming members **16** and **17** are higher in the side where the screw blade is raised with the rotation of the feeding screw **6** as seen in the rotational axis direction of the feeding screw **6** than in the side where the screw blade is lowered with the rotation of the feeding screw **6**. For this reason, the heights of the damming members **16** and **17** are settable correspondingly to the developer surface heights in the sides where the damming members **16** and **17** are provided. For this reason, when compared with the case where the damming members **16** and **17** have the same height as in Embodiment 1, it is possible to suppress inconveniences such that the discharge of the developer is excessively suppressed in the damming member **17** side and that the discharge of the developer cannot be suppressed sufficiently in the damming member **16** side.

Embodiment 3

FIG. **12** is a partial horizontal sectional view of a developing device in Embodiment 3.

FIG. **13** is a vertical sectional view of a stirring chamber as seen from an upstream side. The developing device in this embodiment is constituted similarly as in Embodiment 1 except that no damming member is provided on the inner wall in the side where the opening is provided. Accordingly, in FIG. **11**, constituent elements common to Embodiments 1 and 2 are represented by the reference numerals or symbols common to FIGS. **11** and **12** and FIGS. **7-10**, and will be omitted from redundant description.

As described above with reference to FIG. **9**, during the operation of the developing device **1**, in the region E**1**, the developer surface is higher than in the region E**2**, so that the leakage out of the developer through the region E**1** is larger in amount than the leakage out of the developer through the region E**2**.

As shown in FIG. **13**, in Embodiment 3, the damming member **16** was disposed only in the region E**1**, but no damming member was disposed in the region E**2**. As a result, it was substantiated that even only by the damming member **16**, it is possible to effectively suppress the developer leakage through the gap between the return screw **10** and the inner wall of the stirring chamber **15**. The developer likely to pass through the return screw **10** through the region E**1** was brought into collision with the damming member **16** and then was returned again into the developing container **2**, so that the developer excessively discharged to the outside of the developing container **2** was decreased and thus the developer amount in the developing container **2** was stabilized. In the figure, the return screw **10** has a center CH with respect to the horizontal direction and a center CA with respect to the height direction.

As described in Embodiment 2, in the case where the leakage out of the developer through the region E**2** is completely blocked by disposing the damming member **17**, when the developer amount in the developing container **2** becomes large, a necessary discharge amount cannot be ensured in some cases.

For this reason, the damming member is not disposed in the region E2 where the leakage amount is relatively small, so that in the case where the developer amount in the developing container **2** becomes large, the necessary discharge amount was able to be ensured in the region E**2**. As a result, the discharge of the developer through the region E**2** became smooth, so that the leakage of the developer due to the increase in developer amount, an overload of the driving system, and the like did not readily occur.

Embodiment 4

FIG. **14** is a partial horizontal sectional view of a developing device in Embodiment 4.

FIG. **15** is a vertical sectional view of a stirring chamber as seen from an upstream side.

The developing device in this embodiment is constituted similarly as in Embodiment 1 except that a damming member provided on an inner wall in a side remote from an opening has a length, with respect to a rotational axis direction, longer than a damming member provided on the inner wall in a side close to the opening. Accordingly, in FIG. **11**, constituent elements common to Embodiments 1 and 2 are represented by the reference numerals or symbols common to FIGS. **14** and **15** and FIGS. **7-10**, and will be omitted from redundant description.

As shown in FIG. **9** with reference to FIG. **8**, the developer surface of higher in the upstream region E**1** with respect to the rotational direction of the return screw **10** than in the downstream region E**2** with respect to the rotational direction of the return screw **10**, and therefore the developer leakage through the region E**1** is larger in amount than the developer leakage through the region E**2**. Therefore, as shown in FIG. **14**, in Embodiment 4, the damming member **16** disposed in the region E**1** in the upstream side of the rotational direction was formed in a shape longer, along a rotational axis, than a shape of the damming member **17** disposed in the region E**2** in the downstream side of the rotational direction. As shown in FIG. **14**, heights of the damming members **16** and **17** were made equal to each other.

In Embodiment 4, with respect to the direction along the rotational axis direction of the return screw **10**, the length of the damming member **16** is longer than the length of the damming member **17**. By making the damming member **16** longer than the damming member **17**, it is possible to effectively suppress the flowing out of the developer in the region E**1** side, in FIG. **9**, where the developer surface is higher than in the region E**2**.

As a result, as described in Embodiment 2, when the developer in the developing container **2** becomes excessive, the excessive developer overflows both of the damming members **16** and **17** at the same time and then is quickly discharged to the downstream side. For this reason, the developer in the developing container **2** does not readily become excessive.

According to the constitution of Embodiment 2, the lengths of the damming members **16** and **17** with respect to the rotational axis direction of the feeding screw **6** are longer in the side where the screw blade is raised with the rotation of the feeding screw **6** as seen in the rotational axis direction of the feeding screw **6** than in the side where the screw blade is lowered with the rotation of the feeding screw **6**. For this reason, the lengths of the damming members **16** and **17** are settable correspondingly to the developer surface heights in the sides where the damming members **16** and **17** are provided. For this reason, when compared with the case where the damming members **16** and **17** have the same length as in Embodiment 1, it is possible to suppress inconveniences such that the discharge of the developer is excessively suppressed in the damming member **17** side and that the discharge of the developer cannot be suppressed sufficiently in the damming member **16** side.

Further, the length of the damming member **17** with respect to the rotational axis direction of the return screw **10** was made shorter than that in Embodiment 1, and therefore an area, of the damming member **17**, overlapping with an area of the opening **7***a* shown in FIG. **4** became small. For this reason, the flow of the developer flowing into the developer chamber **15** became smooth.

Embodiment 5

FIG. **16** is an illustration of a developing device in Embodiment 5.

In Embodiment 1, as described above, as a part of the resin molded developing container **2**, the damming members **16** and **17** were resin-molded in advance. In this embodiment, the developing device **1** is assembled by mounting damming members **26** and **27**, as separate members, on the developing container **2**. Other constitutions and functions are similar to those in Embodiment 1, and therefore, in FIG. **16**, constituent elements common to Embodiments 1 and 2 are represented by the reference numerals or symbols common to FIG. **16** and FIGS. **7-10**, and will be omitted from redundant description.

As shown in FIG. **16**, at a portion where a damming member **26** of the developing container **2** is mounted, a dovetail groove **26**M is formed with respect to a vertical direction. The damming member **26** is provided with a dovetail mold **26**G adapted to the dovetail groove **26**M. The damming member **26** is, after the return screw **10** is assembled with the stirring chamber **15**, inserted from above thus is assembled with the stirring chamber **15**.

The damming member **26** was formed in a portal shape such that the damming member **26** covers an upper-half space of the return screw **10** while leaving a discharging space for the excessive developer.

OTHER EMBODIMENTS

The present invention can be carried out also in other embodiments in which a part or all of constituent elements of the above-described embodiments are replaced with alternative constituent elements thereof.

Accordingly, the present invention can also be carried out not only in the developing device of a horizontal stirring type in which the developing chamber and the stirring chamber are horizontally disposed but also in a developing device of a vertical stirring type in which the developing chamber and the stirring chamber are disposed at different heights.

The image forming apparatus can be carried out irrespective of types such as one drum type/tandem type, one-component developer/two-component developer, and intermediary transfer type/recording material feeding member type. The image forming apparatus can be carried out irrespective of the number of the image bearing members, the charging method for the image bearing member, an electrostatic image forming system, the development type, the transfer type, the fixing type, and the like.

In the above-described embodiments, only a principal portion relating to toner image formation and transfer is described, but the present invention can be carried out in image forming apparatuses having various uses such as printers, various printing machines, copying machines, facsimile machines, and multi-function machines, by adding necessary equipment, devices and casing structures.

In the developing device of the present invention, the developer is circulated between the first chamber in which the developer carrying member is disposed and the second chamber in which the feeding member is disposed, and the excessive developer is dischargeable from the outside of the circulation path in the second chamber. Further, it is possible to suppress, by the regulating portion, unintentional flowing-out of the developer from the gap between the feeding member and the inner wall of the second chamber in the side opposite from the first chamber as seen in the rotational axis direction of the feeding member provided in the second chamber.

While the invention has been described with reference to the structures disclosed herein, it is not confined to the details set forth and this application is intended to cover such modifications or changes as may come within the purpose of the improvements or the scope of the following claims.

This application claims priority from Japanese Patent Application No. 236712/2013 filed Nov. 15, 2013, which is hereby incorporated by reference.

What is claimed is:

1. A developing device comprising:

a developer carrying member for carrying a developer containing a toner and a carrier;

a first chamber in which the developer to be supplied to said developer carrying member is to be fed;

a second chamber, communicating with end portions of said first chamber, for forming a circulation path for circulating the developer between said first chamber and said second chamber;

a feeding member, provided rotatably in said second chamber, including a normal feeding portion for feeding the developer in the circulation path from one end portion to the other end portion of said second-chamber, and a reverse feeding portion, provided rotatably downstream of the normal feeding portion with respect to a feeding direction of the normal feeding portion, for feeding the developer from an outside of the circulation path toward an inside of the circulation path;

a discharging portion, provided upstream of the reverse feeding portion of said second chamber with respect to a feeding direction of the reverse feeding portion, for discharging an excessive developer in said second chamber; and

an opposing portion provided in said second chamber so as to oppose a peripheral surface of the reverse feeding portion at an overlapping position overlapping with the reverse feeding portion with respect to a rotational axis direction of said feeding member,

wherein said opposing portion includes a projected portion for forming a predetermined clearance with the reverse feeding portion by being projected from a side surface of said second chamber in a horizontal direction, said projected portion being disposed higher than a rotation center of the reverse feeding portion and lower than a top of the reverse feeding portion as seen in the rotational axis direction of said feeding member and which is more remote from said first chamber than a rotation center of said feeding member.

2. A developing device according to claim **1**, wherein said opposing portion is provided upstream of the reverse feeding portion with respect to the rotational axis direction of said feeding member.

3. A developing device according to claim **1**, wherein a side where said feeding member is raised with rotation of said feeding member is a side opposite from said first chamber with respect to the rotation center of said feeding member as seen in the rotational axis direction of said feeding member.

4. A developing device according to claim **1**, wherein said projected portion is non-magnetic.

5. A developing device according to claim **1**, further comprising a second projected portion for forming a predetermined clearance with the reverse feeding portion by being projected from a side surface of said second chamber in a horizontal direction, said second projected portion being disposed in a region which is higher than the rotation center of the reverse feeding portion and lower than a top of the reverse feeding portion as seen in the rotational axis direction of said feeding member and which is closer to said first chamber than the rotation center of said feeding member is.

6. A developing device according to claim **1**, wherein said opposing portion includes a first region where a clearance from the reverse feeding portion is a first gap and a second region where the clearance from the reverse feeding portion is a second gap larger than the first gap.

7. A developing device according to claim **1**, wherein above the reverse feeding portion, a gap in which a clearance between the reverse feeding portion and said second chamber is larger than a clearance between the reverse feeding portion and said opposing portion is formed, and

wherein the excessive developer is dischargeable through the gap.

8. A developing device according to claim **5**, wherein a highest point position of said projected portion at an opposing surface to the reverse feeding portion is higher than a highest point position of said second projected portion at an opposing surface to the reverse feeding portion.

9. A developing device according to claim **5**, wherein a length of said projected portion with respect to the rotational axis direction of said feeding member is longer than a length of said second projected portion with respect to the rotational axis direction of said feeding member.

10. A developing device according to claim **5**, wherein said second projected portion is non-magnetic.

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